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SECOND REPORT ON HUMAN TRYPANOSOMIASIS IN NORTH-EASTERN RHODESIA AND NYASALAND

BY

ALLAN KINGHORN, M.B., TORONTO

JOHNSTON COLONIAL FELLOW, UNIVERSITY OF LIVERPOOL

AND

R. EUSTACE MONTGOMERY, M.R.C.V.S.

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SYNOPSIS

PAGE

I. Introduction 278
II. Physical characters of country in relation to occurrence of tsetse flies 279
III. Distribution of tsetse flies
  1. *Glossina palpalis.*
    (A) In North-Eastern Rhodesia 281
    (B) In Nyasaland 283
  2. *Glossina morsitans.*
    (A) In North-Eastern Rhodesia 283
    (B) In Nyasaland 283
    (C) In North-Western Rhodesia 284
    (D) In the Katanga (Belgian Congo) 284
  3. *Glossina fusca.*
    (A) In North-Eastern Rhodesia 284
    (B) In Nyasaland 284
IV. Habits of *Glossina palpalis* 284
V. Habits of *Glossina morsitans* 287
VI. Gland palpation and puncture 291
VII. Occurrence of cases of Trypanosomiasis 300
VIII. Mode of introduction into country 301
IX. Prophylaxis 302

I. INTRODUCTION

In our previous report,* published in June, 1908, we reviewed shortly the conditions we had found in North-Eastern Rhodesia, mentioned the distribution of tsetse flies so far as we had ascertained it at the time, and made several suggestions as to measures designed to limit the further extension of human trypanosomiasis. Unfortunately, a second report despatched in October, 1908, went astray, so that some of the observations embodied in the present paper are rather belated. It has been deemed advisable, however, to incorporate them for the sake of completeness.

On leaving Madona, on the Luapula river, in February, 1908, we proceeded to Lake Bangweulu and after spending some days on its western shores and on its islands, separated; one of us now covering the country drained by the Chambesi river, while the other followed the Kalungwisi and Luangwa rivers to Lake Mweru, thence along the northern Anglo-Congolese boundary and the British section of Lake Tanganyika. This work was completed at Abercorn in June, 1908. The next few months were spent, partially on an island at the south end of Lake Tanganyika, and partially at a camp established about thirty miles from this lake, on the bluff overlooking the Lovu river. We left for England on the 15th of November, 1908. One of us proceeded straight from Abercorn to railhead—Broken Hill,—the other travelled across the Tanganyika-Nyasa plateau to Karonga, and then by way of Lake Nyasa and the rivers Shiré and Zambesi to Chinde. The expedition reached England on the 27th of March, 1909, after an absence of twenty-three months, some twenty of which were actually spent in the country. The routes followed, together with the distribution of tsetse flies in North-Eastern Rhodesia, Nyasaland, and portions of North-Western Rhodesia and the Congo Free State, will be found on the attached map. Some seven thousand miles, exclusive of small trips, have been covered, and observations have been made over a large portion of these countries, but it should be noted that practically all the places were visited only once, so that no very great degree of finality exists in the work. In a few instances we were able to institute comparisons at different seasons of the year.

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* Kinghorn and Montgomery, 1908. Annals Trop. Medicine and Parasitology, Vol. II, No. 2.

With the exception of the distribution of tsetse flies, most of our information is first hand, as until Europeans started to search for cases of Sleeping Sickness, the natives were in entire ignorance of the disease, and even yet have not grasped the danger which attaches to it. In many parts of the country they denied the presence of tsetse flies, although these were caught within the village.

For instance, at Kundushia's, on the Mansa river the headman said that there were no tsetse flies (*tusembe*) in the neighbourhood. Three specimens of *Gl morsitans* were caught in the village.

At Komba's village, on Lake Tanganyika, we were told that there were no tsetse flies. *Gl. palpalis* was fairly abundant along the lake shore.

This was due, in all probability, to the fact that they did not possess any live stock, for in those districts where domestic animals were found, the owners knew the flies and the disease which they produced.

II. PHYSICAL CHARACTERS OF THE COUNTRY

The general consensus of opinion is that *Glossina palpalis* does not exist at elevations above four thousand feet, and although Dutton and Todd* mention an instance in which they were found above this height, reported on the authority of an officer in the Congo Free State service, confirmatory observations are lacking. In view of this, it is of some interest to take notice of the physical geography of North-Eastern Rhodesia and Nyasaland, since the greater part of these two countries is formed of high plateau ground. Speaking broadly, North Eastern Rhodesia may be described as composing a part of the watershed, running diagonally south and west, which separates the Congo and Zambesi systems, and which, for the most part, reaches an elevation of from four to over five thousand feet above sea level. It is split up into more or less parallel sections by the Luapula, Chambesi and Luangwa rivers, and in many places the fall from the plateau to these river valleys is very abrupt, as, for example, on the west side of the Luangwa where the Machinga escarpment rises very acutely some two thousand feet. This abrupt fall is particularly marked at the south end of Lake Tanganyika and the north end of Lake Nyasa, where, in both cases, it occurs almost at the water's edge. At the south end of Lake Nyasa and in the neighbourhood of Lakes Mweru and Bangweulu, the slope is more gradual, and the level of the plateau is only reached at a distance of forty or fifty miles from the river.

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*Dutton and Todd, 1907. Annals Tropical Medicine and Parasitology, Vol. I, No. 1.

Martin (Les trypanosomes de le Guinée française, 1906, A. Maloine, Paris) mentions that he caught a single specimen of *Gl. palpalis* at an elevation of 1,800 metres.

Neave[*] has reported that the occurrence of *Glossina palpalis* on several of the rivers in the Katanga, stops rather suddenly about 10°30′ S., in some cases coinciding with the abrupt rise to the plateau level. On the Luapula river no such marked transition occurs; indeed the drop between Lake Bangweulu and Lake Mweru is only some seven hundred feet (3,700-3,000 ft.), but the stoppage of the fly at about 11°30′ S. corresponds, more or less, with a change in the vegetation of the river banks. North of that latitude, the banks are fairly well wooded, while south of it, the river runs for long stretches through bare, flat country, and this probably has acted as a bar to the extension of *Gl. palpalis* to Lake Bangweulu and the Chambesi Valley.

Neave also suggests that the absence of *Gl. palpalis* from the greater part of Rhodesia and Nyasaland may be due to the change in the fauna, which occurs in this portion of Africa, from the West Coast type to that of the Eastern and Angolan regions. Apparently this species of fly oversteps the boundary, for it was captured on the Zambesi, between Tete and the Victoria Falls, by Sir John Kirk.[†] Since the conditions on Lake Nyasa, on the Luangwa river and on other tributaries of the Zambesi are quite favourable for the existence of *Gl. palpalis*, it is very important to ascertain as soon as possible whether it is still to be found anywhere along this system of waters.

Altitude is unfavourable to the development of *Gl. palpalis*, probably on account of the temperature. According to Roubaud[‡] the most suitable temperature varies between 25° and 30° C., and on the plateau the mean is lower than this. At Kambole, on the Tanganyika plateau (about 4,800 feet above sea level) where careful records were kept for some years, the mean daily temperature was found to be 21° C., and the variation between 7·2° and 32·2° C. These conditions would hold good for many portions of the country, and it may safely be said that on the plateau the vegetation and temperature approach the temperate more closely than the tropical type. At the level of the lakes and in the large river valleys, the conditions, of course, are much different, and are sufficiently well marked to be quite perceptible in passing from the low to the high levels.

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[*] Neave, 1908. Report of Katanga Medical Commission, London.

[†] Austen, 1903. Monograph of the Tsetse flies.

[‡] Roubaud, 1908. Bulletin Soc. Pathologie exotique, T. I, No. 5.

There are other factors, than the altitude and temperature, which would tend to limit the presence of *Gl. palpalis* in the main portion of the territory with which we are dealing. The annual rainfall, for instance, is comparatively low, from 40 to 50 inches, and the drainage is so complete that, except in the rains (end of October to end of March), all but the main rivers are dried up, so that the air lacks the humidity which is apparently necessary for the development of this species. The lack of shade is another factor. The whole of the country is covered with a very thin type of bush formed by small, scraggy trees which afford very little shade. At frequent intervals the bush is interrupted by grassy 'dambos' or plains, of varying size, which, in the rains, act as reservoirs into which the water drains from the surrounding localities and from which the streams take origin.

The shores of Lake Tanganyika are anomalous, in that the fly is found where there is practically no shade, but the greater humidity and higher temperature are doubtless important factors in determining their presence there.

Most of the streams in Rhodesia and Nyasaland have been insufficiently explored for *Gl. palpalis*, and while it has not as yet been found on many of them, it would be advisable that more time should be devoted to the search before an absolutely negative result is recorded. So far as the general conditions go, there is no reason to suppose that the species would not flourish just as well on many of the more central streams as they do, for example, on parts of the Luapula.

III. DISTRIBUTION OF TSETSE FLIES

1. *Glossina palpalis.*

A. In North-Eastern Rhodesia.

In our earlier report, we said that this fly had been found on both banks of the Luapula river from Kapwepwi's (11°30′ S.) to Kasiwa's, a village on the British side about 10°15′ S. Beyond Kasiwa's, proceeding downstream, the river is bordered by gradually widening, swampy flats, along which the fly has not been found.

We went along the British bank of this portion of the Luapula river in January, at the height of the rains, but could not travel by water as there were no canoes available. Dr. Spillane covered it in October, and reported that he could not find *Gl. palpalis* at that time (commencement of rains).

On the Belgian side, however, the banks are high and protected by trees, and it is quite probable that the species exists farther down stream on this side of the river although we cannot speak definitely on this point.

The fly is also found on the Kalungwisi river, along a small stretch, about ten miles in length, starting just below the old Kalungwisi station and proceeding up-stream. Here the river flows through low hills which are well-wooded to the water's edge. Above these hills to the point of emergence from the Machinga (the hills at the edge of the plateau) and, again, below Kalungwisi boma to Lake Mweru, the river runs between low, grass-covered banks, bounded on either side by wide, marshy flats, and along these portions of its course *Gl. palpalis* has not been found.

On two separate occasions, in May, 1908, just at the cessation of the rains, we explored the river by canoe, but saw no trace of *Gl. palpalis*.

In May, 1908, we followed the Kalungwisi to its junction with the Luangwa river, and then went up this stream for some distance, but were unable to find any trace of the fly, although in many places the conditions were most favourable. In its upper reaches, the Kalungwisi, like so many of the Rhodesian rivers, flows through very wide grassy plains almost completely destitute of cover.

On Lake Mweru.—The fly is not uniformly distributed around the whole shore of this lake, but occurs in small patches where the trees and bushes approach close to the water. On the open sandy beaches it is absent. It is also found for some distance up some of the tributaries of the lake, for example the Luao and the Luchinda, and of course along the Lualaba after its exit from the lake. It is also present on the island Kilwa (Spillane).

On Lake Tanganyika.—*Glossina palpalis* occurs around the whole extent of the British shore, and up the principal confluent of this part of the lake, the Lovu river, for a distance of from fifty to sixty miles from its mouth (i.e., a short distance above the junction of the

Mukotwe river). Above this point, the change in the character of the country probably accounts for its absence. The fly is also found for shorter distances up some of the smaller tributaries of the lake and the Lovu.

The fly was first found on Lake Tanganyika by Spillane in November, 1907 (beginning of the rains). We found it on the Lovu in June, 1908 (dry season), and also at many places on the lake. In July and August, 1908, the fly was traced up the Lovu river by Spillane and S. A. Neave. We utilised canoes in this work.

During the months of March and April, 1908, some time was spent on the shores of Lake Bangweulu and on its islands, as well as along some of its confluents, but on none of these were we able to find *Gl. palpalis.* The western shore of the lake and some portions of the islands have definite, wooded banks, but the northern and eastern sides have not. On these sides, all the tributaries of the lake flow through large swampy plains as they approach it, and these, in turn, expand into immense marshes around the open water. The Chambesi river with some of its affluents (April and May, 1908), the Luapula from Lake Bangweulu to Chongola's village (September, 1907, and March, 1908), and a portion of the Luangwa flowing into the Zambesi (August, 1907), were examined with negative results. These have also been searched by S. A. Neave with the same result.

B. In Nyasaland.

Gl. palpalis has not yet been found on the lake or any of its tributaries. The only portions we have examined are the northern end of the lake, and parts of the Songwe, Lufira, and North Rukuru rivers, in December, 1908.

2. *Glossina morsitans.*

A. In North-Eastern Rhodesia.

In this country *Gl. morsitans* has an extremely wide distribution. The only parts which can be said, with any degree of certainty, to be free, are the Tanganyika-Nyasa plateau, the plateau in the neighbourhood of Serenje, and a small district around Fort Jameson.

B. In Nyasaland.

The fly is reported* as being absent in the mountainous northern districts of the country. Its chief distribution is along the low country between the lake shore and the hills, starting about 12° S., and extending down the Shiré river for some distance.

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* Survey made by the late Capt. F. H. Hardy, R.A.M.C., and Dr. Wykesmith.

C. In North-Western Rhodesia.

The distribution has been given in our earlier report,[*] and includes most of the country north of the hook of the Kafue river.

D. In the Katanga district of the Belgian Congo.

According to Massey,[†] *Gl. morsitans* is present over most of this territory, and we have established the continuity of its area of distribution in the Katanga with the bounding areas in N.W. and N.E. Rhodesia.

3. *Glossina fusca.*

A. In North-Eastern Rhodesia.

A specimen of this species is reported[‡] to have been caught on the Luangwa river close to its junction with the Zambesi.

B. In Nyasaland.

It has been caught on the road running past the elephant marsh, near Chiromo, and also near Kaporo's village on Lake Nyasa, to the north of Karonga. It is not very common at either of these places, and only one or two specimens have ever been caught at a time. We failed to find it near Karonga in December last.

IV. HABITS OF *GLOSSINA PALPALIS*

Our observations accord, in most particulars, with those which have been given by other workers. On many occasions we were struck by the apparent indifference these flies displayed in the presence of food, and although they would alight on the bare skin of a native, they would often remain quiescent for a considerable length of time without making any effort to feed. In this respect they differ most markedly from *Gl. morsitans*, for this species, as a rule, does not waste any time, but proceeds to fill itself voraciously almost as soon as it has settled. So far as our experience goes, *Gl. morsitans* is much the more troublesome.

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[*] Montgomery and Kinghorn, 1908. Annals Trop. Med. and Parasit., Vol. II, No. 2.

[†] Private communication.

[‡] Private communication, Administrator of N. E. Rhodesia.

On the march, wherever *Gl. morsitans* was at all plentiful, all the carriers provided themselves with bunches of leaves, and the constant sound of these striking the skin bore evidence to the viciousness of the flies.

In most places the conditions under which we caught *Gl. palpalis*, approach closely to those obtaining in Uganda and other parts of Africa; that is, there was fairly abundant shade afforded by the trees and bushes along the water courses, but on Lake Tanganyika a most striking difference was noticed. This lake is closed in by precipitous cliffs from one to two thousand feet high, which come to within a short distance of the water. The shores shelve gradually from the foot of the hills, are sandy or pebbly, and are either quite devoid of vegetation, or, at most, furnished with small patches of the reed known locally as 'mtete' or 'bango' (*Phragmites communis*). In only a very few places does this assume any luxuriance of growth, yet it was noted that the fly could almost always be found at even the scantiest collection of isolated reeds. They were frequently seen basking in the sun, on the rocks at the water's edge. The whole picture presented by these rocky beaches with small, scattered patches of reeds differs very materially from what has been considered to be typical '*palpalis*' country, i.e., wooded banks affording plentiful shade. This may be a local peculiarity of the species (*Glossina palpalis*, Rob. Desv., var. *wellmani*, Austen, and intermediate forms between this and the type species), or it may indicate that in the absence of more favourable conditions, other factors being suitable, the fly is capable of a certain amount of adaptability, and this, of course, becomes of some importance in considering the possible extension of the species. We have been informed by Prof. Todd that *Gl. palpalis* is common on long stretches of the Upper Congo, where the banks on either side are covered with grass alone.

On the Lovu river, along the portion examined by us, the banks are covered with a dense growth of the reed we have mentioned above, and only an odd bush or two, yet the fly was very abundant. The shade afforded by the reeds was, however, very deep here.

Many observers have noted a seasonal variation in the number of the flies found, and, curiously, the one or two instances of this which we have seen, have been the reverse of the usual statement that they are more abundant in the wet season.

The Lovu river was visited by Dr. Spillane, the P.M.O. of N.E. Rhodesia, in November, 1907, when the rains were on, and at that time no flies were seen by him; yet when we got there in June, 1908, two months after the close of the wet season, they were particularly plentiful. It is not clear why this should be so, for along this particular stretch of the river there are many villages and an assured supply of food. On an island in Lake Tanganyika, which was visited at the height of the dry season (July), and again at the commencement of the rains (November), there was no apparent difference in their numbers, but these were so great that it would be difficult to draw any definite conclusions. On the lake shore, however, fly were caught during the rains at several places where they were not seen in the dry season.

There is apparently a seasonal variation in the proportion of the sexes. On the island referred to, of 1,409 specimens of *Gl. palpalis* caught in July (height of dry season), 1,282 were males and 127 females, a proportion of 10 : 1. In November, just after the rains had set in, of 401 specimens caught at the same place, 396 were males and only five females, a proportion of 79 : 1. This may indicate that it is at this time of the year that the females are depositing larvae, and that during this process they become less active than in the dry season, when the humidity and the temperature are lower.

In spite of prolonged and careful search, we were never successful in finding pupae, and in this our experience coincides with that of Ensor* in the Soudan. It may have been due to the fact that the island was composed of very rough, broken stone, with very little soil, so that the pupae might easily have dropped into the crevices of the rocks where they could not be found.

Our search was made along the shores of an island, just above the edge of the water and two or three yards inland. We were assisted by five or six 'fly-boys' trained in the work, and although they often brought us pupa cases they were never those of *Gl. palpalis*. On each occasion, several hours were devoted to the work, and during our stay on the island, in the months of July and November, we searched at least half a dozen times. We always selected the places where the shade was most abundant.

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* Ensor, 1908. Reports of the Wellcome Research Laboratory, No. 3.

It is hardly necessary to consider at any length the question as to whether crocodiles form the staple article of diet of *Glossina palpalis*, as has been suggested by Koch.* In captivity the fly will feed on various animals—we have used dogs, monkeys, sheep, goats, hens, a hornbill, and some small birds—and in its wild state the source of food will be determined altogether by the local fauna. In some places where *Gl. palpalis* exists, there are no crocodiles; so that the association of the two is more or less accidental.

For instance, at Madona we were informed by residents of many years' standing that it was an extremely rare event to see a crocodile, yet the fly was plentiful. Again, some of the streams flowing into the Lovu river were too small to harbour crocodiles and yet the flies existed on the streams.

One very common source of food is afforded by several species of water birds, especially darters, which are accustomed to sit for hours on dead trees at the water's edge, with their wings widely outspread.

On the island in Lake Tanganyika, of which we have already spoken, the only living things were several species of birds, chiefly water-fowl, some snakes, mice, and a few crocodiles. This island lies at least two miles from the mainland, and has been uninhabited for, certainly, the past twenty years. Although *Gl. palpalis* was extremely abundant, and was found around the whole of the shore, the crocodiles were practically confined to one particular bay, so that all the fly did not have the opportunity of feeding on them. We attempted to feed captive flies on freshly-shot crocodiles, and while they made vigorous efforts to do so, they were unable to pierce even the thinnest portions of the skin of the particular crocodiles we were using.

About 33 per cent. of the flies we examined (61 out of 185), on this island, showed evidence of having fed on blood. In every case, with the exception of one, the blood cells, when recognisable, were oval and nucleated, but we were not able to determine, with any degree of certainty, whether they were from birds or reptiles. None of the birds or crocodiles we shot had blood parasites, *e.g.*, haemogregarines, and the changes produced in the contours of the cells and nuclei by the process of digestion rendered measurements useless. In the odd fly, the blood was human, and quite fresh, and had evidently come from one of the boys engaged in catching specimens.

41·7 per cent. of the *Gl. palpalis* were infected with intestinal parasites of the herpetamonad type. The discussion of these forms is reserved for a future paper.

V. HABITS OF *GLOSSINA MORSITANS*

So far as the time of day at which they are most active, their catholicity of taste in the matter of food, and their preference for dark colours are concerned, the habits of this species are much similar to those of *Gl. palpalis*.

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* Koch, 1907. Deutsche med. Wochenschrift, Jahrgang 33, No. 46.

On several occasions we thought that they showed a more decided preference for khaki than for the dark skin of the native, but this may have been due to the fact that we walked ahead of the carriers and so attracted the fly first.

More or less seasonal variation is observed in the case of this fly, and in some localities apparently depends upon the winds, for during the South-west monsoon they cannot be found on many elevated spots where they exist at other times of the year.

When we reached the top of the plateau at the Lovu river, at the end of May, 1908, *Gl. morsitans* was present, but during August we were unable to get specimens, although there were plenty in the valley below. In October, when the winds had ceased, they could again be found at the edge of the plateau.

Some of the officials who have been many years in the country, deny that there is any great difference in the numbers of the fly in the wet and dry seasons. We were never long enough at any one place to make any observations on this point. One official said that he had noticed that the fly was absent in the part of his district where the soil was clayey, and that they could be found in surrounding areas where the soil was sandy. If this observation is correct, it might be explained by the larvae being unable to burrow into the stiffer soil in order to pupate. Another said that they could always be found in 'mopani' bush, i.e., forest composed of these trees, which are rather far apart and grow with straight trunks. The ground beneath them is covered with a scanty carpet of grass, devoid of undergrowth, as the soil is sandy and not very fertile.

Gl. morsitans requires much less shade than *Gl. palpalis*, and is not commonly found in such close connection with water as this species; indeed, they may be taken miles away from it.

Near Chongola's village, on the Luapula river, the country is one series of immense, bare, and absolutely level flats separated by very small patches of bush. *Gl. morsitans* abounds in this bush, and also in the small, bush-clad ant-hills which dot the plains. They fly from these ant-hills to attack the passing caravans, but are never seen in the absolutely bare flats, unless they have been carried there on the natives. We travelled through this country, in the dry season, for seven hours on one occasion, before reaching a water hole.

Ensor* has noted that the two species have selective spheres and that they do not encroach on one another's territory, and while our observations agree, on the whole, with this, we have caught the two flies together under circumstances which would preclude the possibility of *Gl. morsitans* having followed us to the water.

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* Ensor, 1908. Wellcome Lab. Reports, No. 3.

This was seen more particularly along the coast of Lake Tanganyika, in several of the small bays which were closed in by precipitous cliffs. We landed at these from a canoe, and caught both species together.

They are more resistant to changes of temperature than *Gl. palpalis*, and will flourish at much greater altitudes; in many places we have caught them well over four thousand feet above sea level. They are said to shun human habitations; this depends, apparently, to some extent on the character of the village, that is to say, whether it is clean and well-kept or whether the spaces between the huts are utilised to grow such crops as cassava, for in such we have caught *Gl. morsitans*.

For instance, they have come into the tent when pitched in a village, and have been caught in another while we were palpating the people.

This condition, however, is rather unusual in most parts of the country, so that it is rather rare to see the fly actually inside the villages.

It may be as well, in view of Koch's* statement that *Gl. morsitans* in German East Africa will not attack men, to say that the Rhodesia and Nyasaland varieties do not hesitate to do so, and wherever they are met they become a veritable pest.

The pain felt when a tsetse fly bites is variable. It may be so acute as to feel like a red-hot needle, or, on the other hand, it may be quite painless. This depends altogether on the spot they select. As a rule, no after-effects are noticeable at the site of the bite. In those cases where the fly experienced any difficulty in getting through cloth, it would very frequently cause the wings to vibrate very quickly, with a sharp buzzing sound, as if it were trying to bore through the obstruction. This buzzing sound is most distinctive, and often is the first thing which draws the attention to the presence of the flies when they are very scanty and difficult to catch.

After making all allowance for lack of sufficient observation, there can be little doubt that *Gl. morsitans* is increasing in numbers in these countries. This statement is made by all the Europeans who have been in the territory for any number of years, and while many of them have only taken an interest in the question since Sleeping Sickness has become so prominent a subject, and may, therefore, be jumping to the conclusion, definite evidence exists in some cases.

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*Koch, *loc. cit.*

One settler in Nyasaland, for instance, who kept cattle, had to abandon one locality owing to its invasion by fly, and is now finding that his second estate, which was free of flies when he took it, and on which he has been settled for several years, is very quickly being rendered useless to him in the same way.

There are large herds of cattle, belonging to Europeans, at Fort Johnston, at the south end of Lake Nyasa, and numbers of these used to be driven with impunity to Zomba some years ago. Since that time, however, the fly has spread to such an extent that it is no longer possible to do this.

In one district in N. E. Rhodesia, actual fly maps were made by a competent observer, and these show that the same thing is happening there.

This increase cannot be ascribed altogether to a corresponding increase in the amount of game, for the fly is found in many districts where this is very small, and in other cases the reverse holds good.

The Native Commissioner of the Serenje district of N. E. Rhodesia told us that there is practically no game in the area close to Chitambo's village, yet the fly are very plentiful there.

Along a road, in the Congo Free State, running parallel with the Luapula river, *Gl. morsitans* was present in large numbers, and yet there were no traces of game in the neighbourhood.

Near Abercorn, in N. E. Rhodesia, there are large herds of eland, hartebeest and roan antelopes, while tsetse flies are absolutely unknown. Other examples might be given.

It has been recently suggested that the occurrence of the flies may be cyclical, and, if so, it may account to a great degree for these facts. In Nyasaland, on the South Rukuru river, where tsetse flies are said to have been abundant twenty years ago, there are none at the present time, while they are returning to the Chobi river and Wankies, in Southern Rhodesia, from which they have been absent for some years. There is a native rumour that they are also returning to a portion of the Transvaal.

As in the case of *Gl. palpalis*, the food of *Gl. morsitans* will depend on the local fauna, and it does not follow, as has often been said, that wherever buffalo are found there will also be this fly.

On one occasion, on the west shore of Lake Bangweulu, we covered a piece of country in which a herd of from fifteen to twenty buffalo habitually lived, without meeting with the fly anywhere, even close to the herd.

If buffalo are found in country where *Gl. morsitans* exists, it is altogether natural that the flies should be more abundant in the neighbourhood of the animals, as they do not travel quickly, are local in their habits, remain practically always under cover, and afford an abundant supply of food. Farther than this, we do not think there is any closer connection between this particular or any other species of game. In the country itself, opinion is divided on the question of the inter-relation of tsetse flies and game. Some men state most positively that there is no close connection at all between the two. Others say that buffalo and the fly are always seen together; others that elephant are the selected animals; others that kudu; and so on. These conflicting statements can be explained in part by incorrect observation and in part by prejudice.

VI. GLAND PALPATION AND PUNCTURE

During the period February 24th to June 15th, 1908, we palpated 17,923 natives, of whom 3,056 had palpable glands (post cervical), and with our previous figures the totals are 26,928 and 4,934, so that about a fifth of the people (17·05 per cent.) present the condition. These glands are classified[*] as follows:—

'+'	29, or	0·58 per cent.
'+ –'	115, or	2·33 per cent.
'+ – –'	4,791, or	97·24 per cent.

The results of puncture were:—

Class	No. found	No. punctured	No. infected	Percentage success
'+'	29[†]	29	21	72·4
'+ –'	115	108	1	0·9
'+ – –'	4791	608	0	0·0

Amongst the '+' class we have included two cases in which symptoms of tuberculosis were present and in which the gland juice was purulent, so that when these are excluded the percentage of successful punctures becomes 77·7. It should be noted that all the natives were seen only once, and it is possible, therefore, that had we been able to examine them more frequently a still greater percentage of them might have been found to be infected.

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[*] The classification to which we have adhered is that used by Dutton and Todd, viz.:
'+' glands, (*a*) one gland, estimated size 1·5 × 0·75 cm.
(*b*) several (3 or more) smaller glands, the largest measuring perhaps 1 × 0·75 cm.
'+ –' glands, showing less enlargement than '+' but more than '+ – –'
'+ – –' glands, (*a*) only one or two glands measuring 0·5 × 0·25 cm.
(*b*) many tiny, usually hard and shot-like glands, which were only just palpable.

[†] In two of these cases, negative on gland puncture, and in which there was no apparent cause for the enlargement, the blood and cerebro-spinal fluid were centrifuged and examined, but with negative results.

A word may be said here with reference to the classification. In all our ' + ' cases the enlargement was relatively enormous, so much so that in several of them the glands could easily be recognised, on casual inspection, as irregular swellings at the sides of the neck. We had the opportunity of seeing the great majority of the other cases found in the country, and in these the enlargement was also extremely well marked, so that there could not be any hesitation in assigning them to this particular class. All the glands were freely moveable, separate from one another, and of the peculiar, and almost diagnostic, consistency which Hodges* has aptly compared to that of a ripe damson.

In the one positive ' + – ' case we were led to suspect the presence of the disease by this feature alone, before puncture had revealed the trypanosomes in the gland juice.

The ' + –   ' class included glands which are usually few in number, and which are very small and hard—like BB shot. They are most commonly found at the apices of the posterior cervical triangles, and as we have already pointed out, have no specific import, so that a clear distinction may be drawn between them, as being merely 'palpable' as opposed to 'enlarged.'

The intermediate, or ' + – ' class, we have found to be of little use, and our results point to the conclusion that this group is perhaps superfluous. In any such arbitrary classification, however, so much depends upon the interpretation of the individual that it is as well that a somewhat smaller measurement should be adopted than the one which would indicate with any degree of certainty the presence of trypanosomes. This means but little extra work, and increases the efficiency of the method. Our experience bears out that of Dutton and Todd,† and of Martin and Leboeuf,‡ that the larger the glands the more likely is one to find trypanosomes, that is in early cases of the disease.

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* Hodges, 1907, Colonial reports, Uganda, No. 4662.

† Dutton and Todd, 1906, Liverpool School of Tropical Medicine, Memoir XXI.

‡ Martin and Leboeuf, 1908, Bulletin Soc. Path. exotique T., No. 8.

The glandular enlargement may not be general, for in our cases it was the exception to find that the axillary and epitrochlear glands were enlarged concurrently with those in the neck. We have not considered the inguinal glands, as in practically every native there was a noticeable degree of enlargement in these groups.

Some idea of the length of time required for the enlargement to attain a marked degree is afforded by the fact that some of our cases, found on Lake Tanganyika, with decidedly '+' glands, had been seen by Spillane some six months before, and had not been punctured by him on account of the small size at that time. We were informed by one of the medical officers engaged in Sleeping Sickness work in Rhodesia, that he had seen one case in which the enlargement had occurred within three months.

In an endeavour to account for the slight degree of enlargement which is so common, we recorded the approximate age* and the sex of many of the natives (18,512), and the relation of these factors may be seen in the following table :—

Age	Males			Females		
	No. palpated	No. glands	Per cent.	No. palpated	No. glands	Per cent.
0—10	2589	1128	43·5	2944	752	25·5
11—20	1509	434	28·7	1104	175	15·8
21—30	2331	439	14·5	3444	229	6·6
31—40	2066	184	8·9	2090	85	4·0
Over 40	269	7	2·8	186	15	8·0

The gradual decrease in the incidence of palpable glands with advancing age is very marked, and corresponds to a large degree with the general diminution in the lymphoid tissue of the body which is known to occur at this period. It is, however, not clear why there should be such a noticeable difference in the occurrence of enlarged glands in the two sexes. The enlargement is encountered in all parts of the country, and is not related in any way to the distribution of biting flies, tsetse more particularly. To a great degree it may be attributed to general dirtiness, which is always more marked amongst the children.

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* We have assumed that the age of puberty is about 12, and while we endeavoured to estimate the ages of the natives as correctly as we could, we cannot vouch for the absolute correctness of them. We believe that by dividing them into decades we have succeeded in approaching some degree of accuracy.

At one village, near the Luangwa river, where the natives were particularly dirty, we were told that they did not wash, as they were afraid of catching cold.

Conjunctivitis and purulent discharges from the nostrils are extremely common in babes. In some districts, skin diseases, such as 'mperi,' or itch, are frequent, and in others, e.g., amongst the Ankonde at the north end of Lake Nyasa, filariasis may be responsible to some extent. There, nearly every man has some degree of lymph scrotum, and filaria may be found in the juice of the lymphatic glands. It has also seemed to us that there are tribal differences, for in those which are comparatively cleanly, e.g., the Awemba, the smaller incidence is quite noticeable. This supports the supposition of the enlargement being due largely to general filthiness.

Since Dutton and Todd* laid such emphasis on gland palpation and puncture, particularly in the early stages of the disease, considerable discussion has arisen not only as to its value as a method of diagnosis, but also to the efficiency of the measures of prophylaxis based on its application. Their original conclusions were:—

1. 'Gland palpation is by far the most efficient method of demonstrating the presence of trypanosomes in cases of trypanosomiasis.'

2. 'As a rule, enlarged cervical glands, without obvious cause, do not occur in districts from which trypanosomiasis is absent,' with the corollary that 'every negro with enlarged glands must be considered, until the contrary is shown, to be a case of trypanosomiasis.'

3. 'Early cases of trypanosomiasis have enlarged glands, and will, therefore, be detected by gland palpation.'

As in the countries with which we are dealing the detection of the early cases is the end in view, we shall restrict out attention as far as possible to these.

1. 'Gland palpation is far the most efficient method . . . . . .

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* Dutton and Todd, 1906, Liverpool School of Tropical Medicine, Memoir No. XXI.

Dutton's and Todd's figures are, for early cases :—

Gland puncture	98·5 %	successes
Blood (partly ordinary preparations, partly centrifuged)	31·4 %	„
Cerebro-spinal fluid	13·0 %	„

The results obtained by Greig and Gray[*] approach very closely those just given, but as cases in all stages of the disease are included, they are not very valuable for our purpose :—

Gland puncture	97·0 %
Blood	52 %
Cerebro-spinal fluid	84·9 %

Koch's[†] earlier results gave a percentage of 97·4 successful punctures, and he states 'dass dieses Symptom (glandular enlargement) bei den Trypanosomiasis-Kranken ein ganz constantes ist, das nicht wie das Auftreten der Trypanosomen im peripheren Blutstrom starken Schankungen unterworfen ist.' When he found that the trypanosomes were banished from the glands by the use of Atoxyl he was compelled to revert to the examination of the blood in order to control the treatment, and then found that by his improved method, he was able to detect the parasites in 40 per cent. of the cases by a single examination, and in practically all of them after the fifth. He goes on to say that where the examination of large bodies of natives is in question his method would occupy too much time, except in the case where the treatment is being controlled, and adds that for quick diagnosis gland puncture must remain the most practical (zweckmässigste).

Martin and Leboeuf[‡] repeated Dutton's and Todd's work in the French Congo, and their results differ to some extent for cases 'en bon etat' :—

Centrifuged blood	100·00 %	successes (6 cases)
Gland juice (complete)	90·56 %	„
Cerebro-spinal fluid	28·57 %	„

Their technique in centrifuging the blood was most thorough, involving three separate centrifugations, occupying in all between threequarters of an hour and an hour. They return to the question in a second paper,* with practically identical results:—

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[*] Greig and Gray, 1905, Roy. Soc. Sleeping Sickness Reports, No. VI.

[†] Koch, 1907, Deutsche med. Wochenschrift, Jahrgang 33, No. 2.

[‡] Martin and Leboeuf, 1908, Bull. Soc. path. exot. T. I, No. 2.

Centrifuged blood	...	100·00 %	successes (12 cases)
Gland juice ...	...	91·46 %	,,
Cerebro-spinal fluid	...	26·31 %	,,
Finger blood ...	...	36·66 %	,,

There is rather a remarkable falling off in the blood examinations in their 'suspected' cases, 85·71 per cent., as compared with 90·90 per cent. for gland puncture. They conclude, however, that their results are practically the same as those of Dutton and Todd, and that while gland puncture is the best method to employ in travelling, the examination of the blood must be practised in treatment.

Our results from the direct examination of the peripheral blood (fairly thick fresh preparations, using $\frac{3}{4}''$ square cover glasses, Zeiss D objective, and No. 4 eyepiece) agree with those of Thiroux, Wurtz and Teppaz,† that is, in ten cases trypanosomes were not seen. Only a single examination was made in each case, however, and the number is too small for any exact deductions.

In considering the efficiency of gland palpation, it is essential to know with what degree of certainty one may depend upon finding the trypanosomes in cases of the disease, at any or every examination. Gray and Tulloch‡ say that 'trypanosomes are constantly present in the lymphatic glands of early . . . cases . . . and can be found on any day . . . .' Koch also, as we have said, points out much the same thing.

If we were dealing with known cases of the disease, it might be concluded that centrifugation of the blood is the most efficient means of diagnosis, though it must be said that the number of cases on which this conclusion would be based is rather small.

In any one of the methods there is naturally an appreciable margin for error, and not only so, but the thoroughness with which they are practised will affect the result to a great degree. When we come to deal with a country in which the disease is not endemic and in which the examination of large numbers of natives is involved, and where, moreover, the men engaged in the work are not furnished with an elaborate equipment, there can be little doubt that the method of gland palpation and puncture is the most serviceable method and the one which must be adopted as a routine measure.

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* Martin and Leboeuf, 1908, Bull. Soc. path. exot., T. I, No. 8.

† Thiroux, Wurtz and Teppaz, 1908, Bull. Soc. path. exot., T. I, No. 5.

‡ Gray and Tulloch, 1907, Roy. Soc. Sleeping Sickness Reports, No. VIII.

2. 'As a rule, enlarged cervical glands, without obvious cause, do not occur in districts from which trypanosomiasis is absent.'

Low was the first to dissent from this statement, and he pointed out that enlargement of the glands was common amongst natives, unassociated in any way with Sleeping Sickness. The truth of the above dictum depends almost altogether on the meaning which is attached to the word 'enlarged.' If this is taken to mean any gland, however small, which can be distinctly palpated, the observations which have been made on the question, enable us to say at once that there is very little truth in it. If we are to take it that by 'enlarged' we are to understand glands measuring approximately 1·5 × 0·75 cm., the case is different. The figures given by Dutton and Todd lend some colour to this supposition, for of 157 ' + – ' and ' + ' glands punctured by them, both in infected and uninfected regions, only two were found to be infected. A distinction must be drawn between infected and non-infected regions, for in the former, as Dutton and Todd,* Neave† and others point out, glandular enlargement is much more common than in the latter, and, in addition, glands of the larger class are much more abundant. Neave says 'This would tend to show that trypanosomiasis is accountable for enlargement of glands of any size.'

On the whole, our results in Rhodesia, a supposedly non-infected region, bear out those of Dutton and Todd. As we have already pointed out, glandular enlargement in the wide acceptation of the term has no particular significance, but in the case of glands of the ' + ' class, in four out of five examinations the natives showing them were infected with trypanosomes.

3. 'Early cases of trypanosomiasis have enlarged glands, and will therefore be detected by gland palpation.'

That the first part of this statement is correct is recognised by all workers. Greig and Gray‡ state that 'the disease is at first a specific polyadenitis.' While this is broadly true, glandular enlargement is not an absolutely constant sign in the early stages of the disease, for cases have been diagnosed in which the glands had not become palpable. About 8 per cent. of known cases of trypanosomiasis will not be detected by gland palpation.

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* Dutton and Todd, 1906, Memoir XXI, Liverpool School Trop. Med.

† Neave, 1908, Report of Katanga Medical Commission.

‡ Greig and Gray, 1905, Royal Soc. Sleeping Sickness Reports. No. VI.

The great divergence of opinion that exists, is, in regard to the application of gland palpation to methods of prophylaxis; the chief objections being that it fails to detect an appreciable number of the cases, that it entails hardship on those natives unfortunate enough to have big glands, that the natives will evade its application, and that it is an expensive scheme to carry out. The second and third of these items need not be considered, as the objections cannot properly be against the method; since, if they occur, they are attributable to injudicious handling of the natives by the officials concerned in the work. The objection that all the cases will not be found by the method is valid. In order to stamp out the disease in a district, the ideal procedure would be to stop absolutely native movements, and to prevent the infection of fresh natives in the area, by the isolation of every case of the disease and the removal of the remaining population from contact with tsetse flies, *Glossina palpalis* more particularly. Since it is manifestly impossible to carry any such scheme entirely into effect, we have to revert to measures which will tend to check the spread of the disease, even though these be imperfect. Dutton and Todd do not claim that their procedure will entirely prevent Sleeping Sickness from spreading; all they say, is, that it will prevent the disease from infecting new districts with the rapidity noticed in the past, and in the meantime improved methods both of prophylaxis and treatment may be brought to light. So far as treatment is concerned, we are in much the same position as we were four or five years ago, that is to say the results are not at all promising, so that we are still compelled to fall back on imperfect methods of checking the advance of the disease. If natives are to be allowed to pass from infected to non-infected regions, the fact remains that no better method of detecting the disease in the early stages has yet been put forward than the application of gland palpation. Of course to complete the method, gland puncture must be employed as well, and this has always been stated to be an integral part of the procedure. It is surely better to stop the nine out of ten cases, which the method will detect, from travelling, than to allow the whole ten to go, just because the odd one will be missed at the time. If this tenth man were registered on leaving his home, and required to present himself for examination at stated intervals, the disease would probably be diagnosed before sufficient time had elapsed for him to become a source of danger in his new surroundings.

This brings up the question of the registration of the native population. Wherever this is feasible, it is desirable that it should be done, as in no other way can the native be so effectually controlled and traced. It is an important preliminary step to the adoption of a pass system.

In North-Eastern Rhodesia, where the conditions are perhaps more favourable than in those countries in which *Gl. palpalis* is found everywhere, the scheme of fighting Sleeping Sickness, based on the application of gland palpation and puncture, is in full working order, and is apparently being accompanied by a considerable amount of success.

The question of the expense depends altogether on whether the eventual results will justify its incurrence. We believe that to obtain the fullest benefit, special medical officers, who have some experience in the work, will have to be appointed, and of course this is rather costly.

In tropical Africa, the development of the country is dependent upon a plentiful supply of native labour, and in some parts, at least, the greater part of the revenue is derived from the imposition of hut taxes; so that it is an important matter that as great a percentage as possible of the natives should be in a position to work. It is certain that if the disease is allowed to go on spreading, the development of many of the African colonies will come to a standstill, so that the cost of any measures designed to check the advance of Sleeping Sickness will be cheap in the end. This is a matter which must be settled in each country, as it will depend upon the area to be guarded, upon the density of the population, and upon the amount of traffic which is allowed to go on.

We must confess that from what we have seen in Rhodesia we are in favour of gland palpation. We believe that, combined with gland puncture, it is a most useful measure, and one which will render real service in preventing any rapid extension of the disease to 'clean' areas. Within the infected areas, it is the most practical method of isolating infected natives. The conditions present in the particular country concerned may possibly affect the results obtained, but if it is seriously and efficiently applied, we consider that the results will more than justify the cost.

VII. OCCURRENCE OF CASES

The Principal Medical Officer, Dr. Spillane, in a tour made during October and November, 1907, found twenty-six cases of the disease in North-Eastern Rhodesia, two in villages on the Mansa river (a tributary of the Luapula), eleven in the vicinity of Lake Mweru, and thirteen on Lake Tanganyika. About the same time, we found three cases in villages near the Luapula, and during our later trip we diagnosed eighteen more, two on Lake Mweru and sixteen on Tanganyika. With a few additional cases, which have since been found by the various medical officers, there are between fifty and sixty known ones in the country.

The one case found in Nyasaland has an interesting history. It is that of a boy who had accompanied his master from that country down the Congo river to its mouth. From there he had gone to Cape Town, and finally returned to his home by way of the Zambesi. This illustrates the extent to which some of these natives will travel in the employ of Europeans.

Only four of our cases were in women. The remaining seventeen were in males varying in age from ten to forty years. The great majority of them were adults. With the exception of two, in whom clinical symptoms were present, all were apparently quite healthy, and the only sign observable was enlargement of the lymphatic glands in the neck.*

Some of them said that they had had occasional attacks of fever and headache; others that they had not been ill at all. Headache is, however, such a common complaint amongst natives, due usually to constipation, that no attention need be paid to it, unless it is exceptionally severe.

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* These cases were seen only once, so that we are unable to say whether there were any slight disturbances of the body temperature or the pulse which may be present in otherwise apparently normal cases of the disease. So far as we could determine at the time, the natives we found to be infected were quite free from any symptoms.

It was an everyday occurrence to have carriers come up complaining of 'mutu, or headache, and this could almost always be relieved by a dose of some purgative.

No loss of strength, emaciation, skin eruptions, tremors or mental disturbances were noticeable. In the two clinical cases, tremors, emaciation, and inability to walk were the principal symptoms present. We never saw a case sufficiently advanced to show mental symptoms or coma.

Insanity is said to be a common early symptom of the disease, but in two cases which we saw, and on which we performed lumbar puncture, no parasites were found in the cerebro-spinal fluid.

VIII. MODE OF INTRODUCTION

We have stated in our previous report that some of the cases on the Luapula river have apparently brought the disease into Rhodesia by way of the Katanga. The foci on Lakes Mweru and Tanganyika are due to direct extension from the immediately contiguous infected areas in the Congo Free State. On the Mweru side, the disease has been gradually spreading up-stream from the Congo, along the Lualaba, until it reached Lake Mweru probably four or five years ago. In the Congo Free State, on Lake Tanganyika, imported cases existed at Moliro, just over the international boundary, in 1901; at Baudoinville in 1902; and at Vua, between these two places, about the same time. Within the last two or three years such a large percentage of the native population, along this portion of the lake, has died from Sleeping Sickness that the White Fathers have been compelled to abandon their missions.

On both lakes, the tribal and political boundaries do not coincide, and on both, the paramount chiefs (Mpweto and Moliro) live in Belgian territory. There has always been constant communication between the people on either side of the line, and to this the introduction of the disease into Rhodesia has been due. In eliciting the past history of our cases it was extremely common to find that a native had been born in a village on the British side, had then been taken as a child into the Congo, had afterwards returned to our territory, and finally settled down in a fourth village. The same may be said of the villagers on the eastern side of Lake Tanganyika, except that here the movement was into German East Africa. On both Lake Mweru and Tanganyika, the most heavily infected villages were those directly contiguous to the Congo Free State. The further extension of the disease has been aided by the free communication, chiefly in canoes, which has been going on from village to village.

Although there has been free communication with German East Africa, it is rather improbable that many of the cases were contracted there, as the disease was introduced into that country (i.e., the eastern shores of Tanganyika) from the Congo Free State* about the same time that it was, in all probability, introduced into Rhodesia, that is to say, not later than 1905. Comparatively few cases have been reported from the Bismarckburg section of German East Africa, which is the portion bounding North-Eastern Rhodesia.

Since its introduction into British territory, it has almost assumed endemic proportions on Lake Tanganyika. In November, 1907, twelve cases were found; in June, 1908, sixteen additional ones; and others since then; so that there is (or was, as they have since been moved) hardly a village on the lake shore in which one or more infected natives has not lived.

We have seen enough on this lake to make us realise very fully the great importance of international co-operation in dealing with Sleeping Sickness. However good a system of fighting the disease may exist in any one country, its efforts are sure to be retarded if the neighbouring territories remain apathetic. When the authorities in Rhodesia commenced to isolate the infected, some of them, and in one or two cases whole villages, immediately decamped over the border, where they not only constituted a source of danger to their new country, but remained one to that which they had left, for the probability existed that they would find their way back to their old villages as soon as they thought the vigilance of the authorities had relaxed.

IX. PROPHYLAXIS

From the reports published in various parts of Africa it is quite evident that it is useless to attempt to advance a system of prophylaxis which will apply equally well to every country. Certain well-defined methods of procedure exist, but so many factors have to be considered that each country has to make a choice of those means which are best suited to the local conditions. For instance, in a country like the Congo Free State, where *Gl. palpalis* is omnipresent, it would be impossible to move the population away from it, so that such measures as clearing would have to be adopted. In Rhodesia, on the other hand, it has been possible to adopt rather drastic measures, partly owing to the physical configuration of the country, partly on account of the restricted distribution of *Gl. palpalis*, partly on account of the scantiness of the population, and partly on account of the lack of any very great commercial movement amongst the natives.

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* Colonial reports, German East Africa, for the year 1905-6. No cases of Sleeping Sickness had been found in the Bismarckburg section at this date.

At one time native transport was an important item, as all goods passing into the Katanga and eastern portions of the Congo Free State went through the country, but with the advent of the railway in the South, and the adoption of the Congo river as the transport route to the East of the Free State, these movements were interrupted. Except for the inter-tribal communication along the border, there is no inducement for the Rhodesian natives to go into the Congo. A certain number did go to the Katanga mines for work, but this was never very popular and never affected any great number. The more natural outlet for the labour has been to the South.

Before we left England in May, 1907, we suggested, on general grounds that natives of North-Eastern Rhodesia should not be allowed to seek work in the Katanga, and that the Luapula river should be closed for traffic. The advisability of this measure became still more apparent very shortly after we had entered the country, particularly as several cases of human trypanosomiasis had been found amongst natives who had been in that portion of the Congo Free State, and who had apparently contracted the disease while there. Consequently in November of the same year we insisted more strongly on the importance of the step, and at the same time suggested that the canoes along the Luapula river should be confiscated, that the Congo Free State authorities should be requested to co-operate in this work, that all cases of the disease should be segregated, and in order that this might be done that special medical officers should be appointed for Sleeping Sickness work, that villages should be removed from the vicinity of *Gl. palpalis*, and where this was impossible that clearings should be made. In December, and again in our first published report, we reiterated these suggestions with a few additional ones of minor importance. The regulations which were finally adopted were much along these lines, and are, briefly:—

1. The Congo Free State and German East Africa are regarded as infected countries, and communication with them has been stopped.

2. All villages, except in two or three instances, have been moved away from contact with *Gl. palpalis.*

3. Certain districts of the country are regarded as infected, and communication between them and the other portions of the territory prohibited. These infected areas are three in number, one including the country around Lake Tanganyika, the second that around Lake Mweru, and the third that along the Luapula river.

4. Three special medical officers have been appointed, one for each of the infected regions, to travel constantly and search for cases of the disease.

5. All cases of human trypanosomiasis are segregated in special camps, in fly-free areas, for treatment.

6. All canoes have been confiscated, and fishing on 'fly' (i.e., *Gl. palpalis*) waters forbidden.

7. Clearings are made at necessary places, e.g., around the few villages which have been allowed to remain on the shores of Lake Mweru, and at several ferries.

The vigorous enforcement of these regulations seems to be meeting with success, for from November, 1908, to January, 1909, no further cases of the disease were found. The efficiency of the scheme depends upon the application of gland palpation and puncture, and, so far as one can see, it is working satisfactorily, but some time must necessarily elapse before a definite opinion can be given as to what the ultimate result will be. Apart from the transmission of the disease by coitus,* and the question of whether any other tsetse fly than *Gl. palpalis* is a natural transmitter of *T. gambiense*, this will largely depend upon the personnel of the staff, and in this connection we cannot do better than quote the remarks of Neave†:—

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* Koch, 1907, Deutsche med. Wochenschrift, Jahrgang XXXIII, No. 46.

† Neave, 1908, Report of Katanga Medical Commission.

'The personnel will have to have their hearts in the work, and 'spare no pains or energy. Those who work just sufficiently to 'conform to the letter of their agreements with their employers, with 'the mere object of getting their pay and returning home with the 'least expenditure of exertion, will be worse than useless, as the fact 'of their being on the spot will lull the anxiety of the world, while 'the disease will progress onwards round them. The work has a 'tendency to be disheartening, and it is only those properly qualified 'men who will doggedly spend all their time in the cause that are 'likely to succeed, and then only with a knowledge of the native, 'together with that peculiar tact and firmness necessary in the treat-'ment of him.'

One or two specific dangers may be pointed out, and these are, that as the natives on the Congo side of the borders have not been moved, nor deprived of their canoes, there may be some temptation for the British natives to go back to the rivers. The co-operation of the Belgian authorities should be requested in order to more fully safeguard these, as yet, practically uninfected regions. There may also be a tendency for some of the natives to return stealthily to the rivers, the Luapula more particularly, in order to fish with weirs, and to plant crops; this can only be safeguarded by periodical inspections. Unfortunately, there is also a necessity to guard against the short-sighted policy displayed by some Europeans in attempting to make the natives evade the regulations when it suits their convenience, in spite of the penalties which are attached to infringements of the law.

There is not much danger of the natives in the 'infected' areas doing any more than simply crossing the boundary for a very short distance, for it so happens that the division between the infected and clean portions is practically a tribal one, and this is very advantageous.

In Nyasaland it is altogether probable that other cases similar to the one which has been diagnosed are present. Many of the natives, particularly of the Mombera and West Nyasa districts, have worked in the Katanga; when we were at Madona we saw a number of them passing through on their way back home. Not only this, but as most of the skilled labour and personal servants in the East Central portions of Africa are natives of this Protectorate and travel much more freely in search of work than the raw native, as in the case recorded above, many of them have been in dangerous localities.

These cases can only be found by a systematic search by properly qualified medical men.

At the same time, medical men can do other most useful work in mapping out the distribution of various biting insects, and conducting preliminary enquiries into the incidence of cattle and other diseases. However, it should be distinctly understood that the work in connection with Sleeping Sickness is sufficiently arduous to require undivided attention, and the tendency which occasionally is seen to add this work to the duties of the ordinary district medical officers can only result in the work being indifferently executed.

This also applies to the clean areas of N.E. Rhodesia, for it must not be forgotten that the first case of human trypanosomiasis diagnosed there was at Chinsali, on the Tanganyika-Nyasa plateau, where no *Gl. palpalis* exist.

The natives should be encouraged to apply for passes when they are about to travel. Provided no unnecessary difficulties are placed in the way of these being obtained, the natives will, in time, apply for them as a matter of course. We found that whenever we had occasion to send a messenger, he would always come up and ask for a note before leaving.

The eventual fate of both Rhodesia and Nyasaland, to say nothing of other territories which bound them, depends on what species of tsetse flies can convey the disease in nature. *Gl. palpalis* has only a comparatively small distribution, so far as we know, but that of *Gl. morsitans* is extremely wide, so that if this species can transmit *T. gambiense* the greatest danger exists.

It is admitted that mechanical transmission is possible, but whether it plays a very extensive rôle in nature, in determining the spread of the disease, is questioned. In any case, the odds against it occurring are enormous, for even in laboratory experiments with *Gl. palpalis*, the number of flies which has been required for a successful result is extremely large, and the conditions under which these experiments have been carried out in the laboratory would occur but very seldom in nature. Whether, however, the position that the possibility of it happening in nature can be ignored, is rather questionable. We believe that mechanical transmission is responsible for the spread of certain cattle trypanosomes, and some support for the supposition that it may take place in the human disease is afforded by the observations of Martin, Leboeuf and Roubaud on the occurrence of hut-infections, which they are inclined to attribute to the agency of such domestic mosquitoes as *Stegomyia* and *Mansonia*. That *Stegomyia* will transmit *T. gambiense* we know.*

With *Gl. morsitans* the probability of mechanical transmission happening is perhaps slight, but the danger will be proportionate to the number of cases which are present. This fly is not nearly so local in its habits as *Gl. palpalis*, and consequently is not afforded the same opportunities of acting as carrier. It is very surprising to notice, even in the case of *Gl. palpalis*, the slow rate at which the disease spreads under the most favourable circumstances. In two or three villages on Lake Tanganyika where this fly, as well as *Gl. morsitans*, was caught in the gardens, and into which the disease, in all probability, was introduced four or five years ago, only nine or ten cases of the disease were found, and if this is so, it is quite conceivable that the rate of spread, in the event of *Gl. morsitans* being an *active* transmitter, as opposed to a *mechanical* one, would be much slower.

Gl. palpalis is restricted to the immediate vicinity of water, so that it has constant opportunities of feeding on the natives when they come to wash, fish, and draw water. *Gl. morsitans* is not restricted to these localities, but is usually found in the bush, and, in general, avoids the villages and the gardens which surround them. Consequently the natives are not exposed to the bites of this fly in the same way as they are to those of *Gl. palpalis*.

On the other hand, it cannot be regarded as settled that *Gl. morsitans* transmits merely mechanically. In some parts of Africa, *Gl. palpalis* transmits various cattle trypanosomes which in other localities are carried by *Gl. morsitans*, and other examples of the same nature might be cited. If we institute analogies with other protozoa, we see that malaria, for instance, is not transmitted merely by one particular species of mosquitoes, but that even many different genera are implicated. The same thing is seen in the case of redwater and ticks. Recently Kleine† has made experiments which suggest that a cycle in the life of trypanosomes does occur in tsetse flies, and it should be noted that he was working with *Gl. palpalis* and *T. brucei*, which is not ordinarily transmitted by this species. He thinks that, in nature, *Gl. fusca*, by which *T. gambiense* has been transmitted experimentally, spreads human trypanosomiasis.

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* Fülleborn and Mayer, 1907, Archiv. f. Schiffs- und Tropenhygiene, Bd. XI, Heft XVI.

† Kleine, 1909, Deutsche med. Wochenschrift, March 18.

The confirmation of this work by Bruce, who used in his experiments *Gl. palpalis* and *T. dimorphon* and *T. gambiense*, is an additional argument for using *Gl. morsitans* in a similar set of experiments.

The principal argument that *Gl. palpalis* is the natural carrier of Sleeping Sickness is that the geographical distribution of the two coincide to a great extent, and this is certainly a most striking fact. The waterways have always been used as highways in preference to land routes, and also as sources of food, so that the spread of the disease along them has been greatly facilitated by the abundant opportunities afforded the very local *Gl. palpalis* to feed on both infected and uninfected people. Even in those cases in which other species of tsetse flies have been found in association with *Gl. palpalis*, the possible share they may have had in the spread has been overshadowed by that of this particular variety. It is only within the last three or four years that the disease has spread far enough to come in contact with other species of tsetse flies, *Gl. morsitans* more particularly, in territory where *Gl. palpalis* does not exist. As we said above, we should naturally expect that transmission by this fly would go on very much more slowly than by *Gl. palpalis*. The question can only be settled by means of a patient and thorough investigation; it is one which should be carried out without delay. If it can be shown conclusively that *Gl. morsitans* will not transmit, except mechanically, the saving in expense to the various administrations concerned will more than balance many times the cost of the work, and if, on the other hand, it should be shown that *Gl. morsitans* is a *natural* carrier, there will yet be time to take more active steps to protect the threatened countries from invasion. Until the question is answered decisively, the possibility must never be forgotten, and must be acted upon to some extent.

In conclusion, we may refer to the conditions under which labour is allowed to leave both Rhodesia and Nyasaland. Quite recently arrangements have been made with the administration of Southern Rhodesia that no labourers from the British colonies to the north shall be accepted unless provided with Government passes. In order that the natives can obtain these passes, they must be examined medically, and in addition are examined a second time when they have reached their destination. No natives from a Sleeping Sickness